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LETTER REPORT COVER SHEET

DATE: 9 Aug 76

REPORT: Evaluation of Revised Approach Lighting Criteria.

IFC-SP-76-2

REPORT NO: IFC-LR-76-1

TYPE: X INTERIM / FINAL

INTRODUCTION

The Federal Aviation Administration (FAA) has directed conversion of all ALSF-1, Category I ILS approach lighting systems with sequenced flashing lights to the Simplified Short Approach Lighting System with Runway Alignment Indicator Lights (SSALR) and Medium intensity Approach Lighting System with Runway Alignment Lights (MALSR).

Although the FAA directive affects civilian aerodromes only, the Air Force is concerned that the lighting change may have an adverse affect on the operational capability of the Air National Guard, Air Force Reserve, and Air Defense Command units which operate from these airfields.

Therefore, Headquarters Air Force has requested the USAF Instrument Flight Center (USAFIFC) conduct an in-flight pilot factors (PIFAX) evaluation of the SSALR and MALSR approach lighting system. This evaluation will provide the data necessary for the Air Force to formulate a position on the operational acceptability of the SSALR and MALSR systems.

This interim report summarizes the IFC/RD findings of the pre-validation portion of this evaluation.

NOTE: The pre-validation flights were conducted in VFR weather conditions.

REQUESTING AGENCY
Headquarters USAF

BEGINNING DATE	COMPLETION DATE	TEST AIRCRAFT	TEST SITE
April 1976		T-38	Randolph AFB TX

	TITLE	OFFICE SYMBOL	TELEPHONE EXT
PROJECT OFFICER: Major Kenneth J. Kerkering		IFC/RDF	4114
PROJECT ENGINEER: Mr Gabriel P. Intano		IFC/RDU	2785
SYSTEMS ENGINEER: Mr George A. Rex		IFC/RDU	2785
Mr Orrin C. Kopff		IFC/RDU	2785
PREPARED BY: KENNETH J. KERKERING, Maj, USAF	Chief, Fighter/Trainer Br/IFC/RD	IFC/RDF	4114
DIVISION CONCURRENCE: JOHN H. CARPENTER, Lt Col, USAF	Chief, Research and Development Div/IFC	IFC/RD	4114
IFC APPROVAL: DONALD F. ROBILLARD, Col, USAF	Commander/IFC	IFC/CC	3320

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ATTACHMENTS: APPENDICES TABLES FIGURES

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CONCLUSIONS

General:

1. The five-step intensity levels of ALSF-1 and the modified SSALR approach lighting systems were much more adaptable to varying ambient light conditions.

2. The ALSF-1 approach lighting system was acquired at a much greater distance from the runway than the MALSR lighting system under similar conditions.

3. The SSALR system with modified intensity levels, comparable to the ALSF-1 system, was acquired at a greater distance from the runway than the MALSR system under similar conditions.

4. The sequenced flashers on the ALSF-1 system did not give a definite flow toward the runway with the approach lights set on step 5 (full bright).

5. The sequenced flashers on the MALSR system did not provide a definite movement toward the runway. They looked as if they were flashing in a random manner.

6. It was found at several fields that the MALSR lighting system was not properly aligned with the instrument approach flightpath. This made the approach lights and sequenced flashes very difficult to acquire.

7. Generally airfields which have ALSF-1 systems that were supposed to be converted to MALSR have not been converted.

8. Roll bars on the MALSR system tended to be less definitive than those on the ALSF-1 system.

RECOMMENDATIONS

All of the approaches flown against the three lighting systems were flown under VFR weather conditions. Viewing the various approach lighting systems under these circumstances, no definite conclusions could be drawn as to the relative value of each system under low ceiling and visibility conditions; however, based on the general conclusions, an in-depth study of the approach lighting systems at Category I ILS minimums (200 - 1/2) is felt to be warranted before a committment is made to modify existing approach lighting.

DESCRIPTION OF TEST ITEMS

Pilot factors test data will be collected on three Category I ILS approach lighting systems. These are: Approach Lighting System with Sequenced Flashing Lights (ALSF-1), the Simplified Short Approach Lighting

System with Runway Alignment Indicator Lights (SSALR) and Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR).

The Category I ALSF-1 (figure 1) consists of a light bar (approximately 13-1/2 feet long with five equally spaced lights) at each 100-foot interval starting 200 feet from the runway threshold and continuing out to 3000 feet from the threshold. All light bars are installed perpendicular to the extended runway centerline and all lights are aimed away from the runway threshold. The centerline light bar at 1000 feet from the threshold is supplemented with eight additional lights on either side forming a light bar of 100 feet and containing 21 lights. This bar is called the 1000-foot distance marker crossbar (or simply, 1000-foot bar). All of the aforementioned lights are white. The light bar 200 feet from the threshold is 50 feet long, contains 11 red lights, and is called the terminating bar. Two light bars, each containing five red lights, are located 100 feet from the threshold, one on either side of the centerline, and are called wing bars. The inner light (nearest runway centerline) of each wing bar is located in line with the runway edge lights. A row of green lights on five-foot centers is located near the threshold and extends across the runway threshold and outwards a distance of approximately 45 feet from the runway edge on either side of the runway. These lights are called the threshold bar. In addition to the steady burning lights, the ALSF-1 configuration is augmented with a system of sequenced flashing lights. One such light is installed at each centerline bar starting 1000 feet from the threshold out to the end of the system 3000 feet from the threshold. These flashing lights emit a bluish-white light and flash in sequence toward the threshold at a rate of twice per second. The flashing lights appear as a ball of light traveling toward the runway threshold at a speed of approximately 4100 miles per hour.

The SSALR lighting system (figure 2) consists of seven five-light bars located on the extended runway centerline with the first bar located 200 feet from the runway threshold and at each 200-foot interval out to 1400 feet from the threshold. Two additional five-light bars are located, one to either side of the centerline bar, 1000 feet from the runway threshold forming a crossbar 70 feet long. The spacing between individual lights is 40-1/2 inches for the centerline bars and five feet for other bars. All lights in the system are white. In addition, Runway Alignment Indicator Lights (RAIL) are included. The RAIL portion of the facility consists of sequenced flashers located on the extended runway centerline, the first being located 1600 feet beyond the approach end of the runway threshold with successive units located at each 200-foot interval out to the end of the system (2400 or 3000 feet). These lights flash in sequence toward the threshold at the rate of twice per second.

The length of the SSALR may either be 2400 feet or 3000 feet, depending on the glide slope angle. When the glide slope angle is less than 2.75°, the length of the approach lighting system will be 3000 feet, and 2400 feet when the glide slope angle is 2.75° or higher (figure 2).

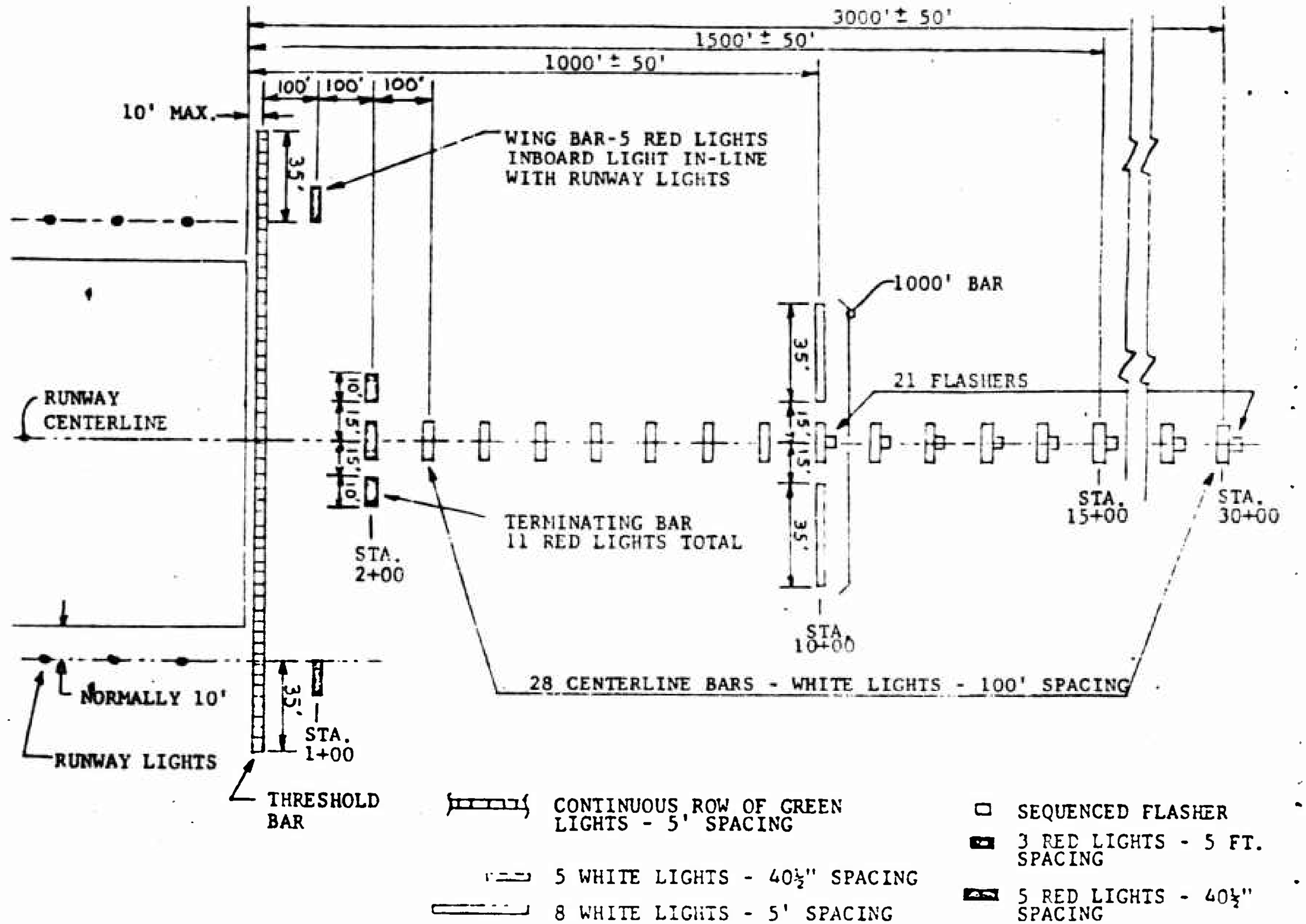

FIGURE 1 ALSF-1 CONFIGURATION

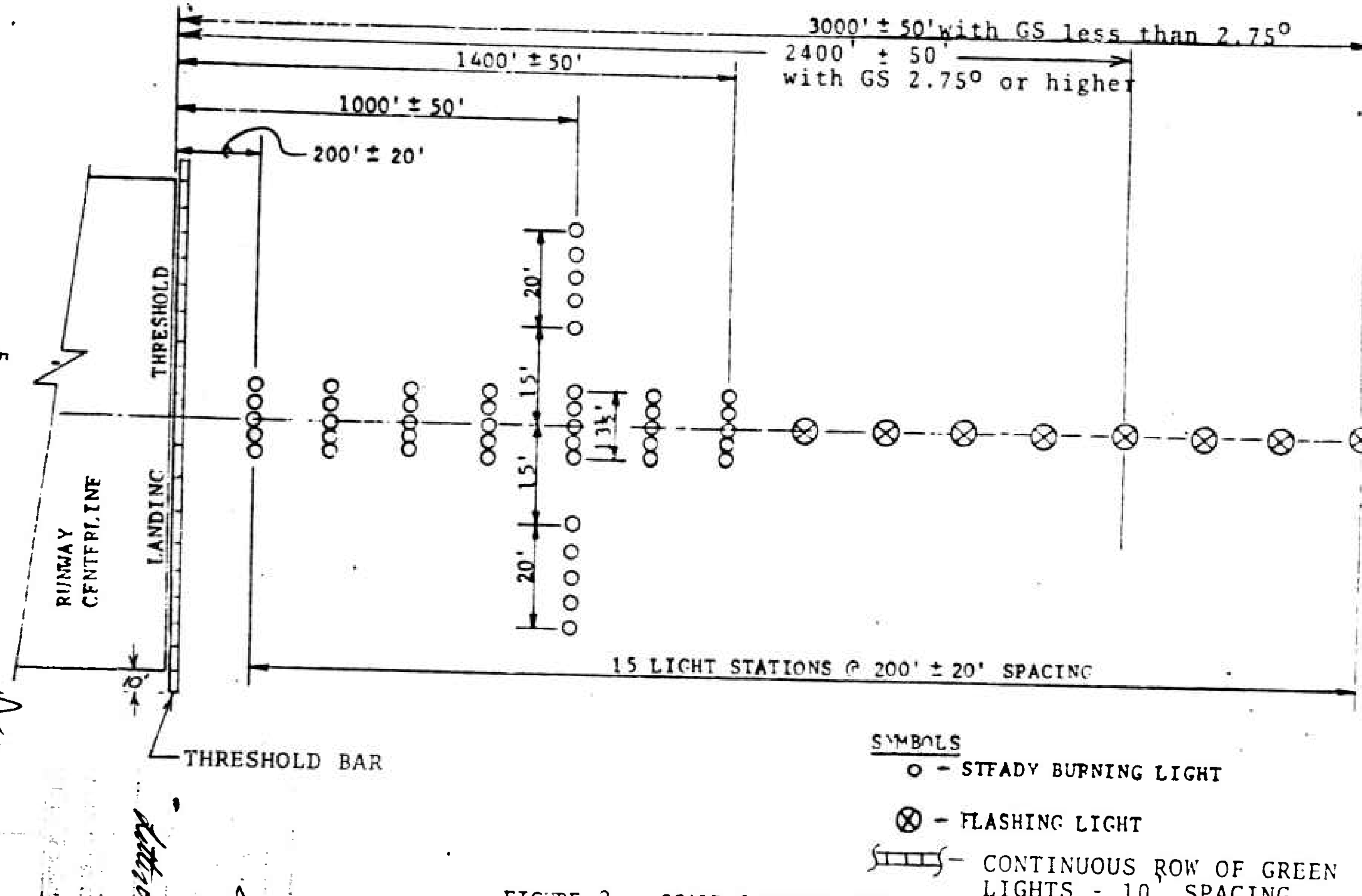

FIGURE 2. SSALR CONFIGURATION
2400 and 3000 FOOT SYSTEMS

The MALSR consists of seven five-light bars located on the extended runway centerline with the first bar located 200 feet from the runway threshold and at each 200-foot interval out to 1400 feet from the threshold. Two additional five-light bars are located, one to either side of the centerline bar 1000 feet from the runway threshold forming a crossbar 66 feet long. The spacing between individual lights in all bars is approximately 2.5 feet. The RAIL portion of the facility consists of sequenced flashers located on the extended runway centerline, the first being located 1600 feet beyond the approach end of the runway threshold with successive units located at each 200-foot interval out to the end of the system (2400 or 3000 feet). These lights flash in sequence toward the threshold at the rate of twice per second.

As with the SSALR system, the MALSR may either be 2400 or 3000 feet, depending on the glide slope angle. When the glide slope angle is less than 2.75°, the length of the approach lighting system will be 3000 feet and 2400 feet when the glide slope angle is 2.75° or higher (figure 3).

DISCUSSION

The pre-validation portion of SP 76-2 has consisted of finding suitable operating locations throughout the United States. Various flight profiles and equipment to be used in the data acquisition portion of the project were also examined.

Several factors were considered when selecting the operating locations: the type of approach lighting system at each airfield, the capabilities of the airfields to support T-38 operations, and the necessity for the weather to be at 200 - 1/2 for extended periods of time were all extremely important.

Initially the lighting systems at airfields in the Randolph AFB area of operations were investigated. All of these airfields had either the ALSF-1 or MALSR approach lighting systems. After these fields were examined, the area of operation was then expanded to include airfields throughout the United States

In our quest for acceptable operating locations, the California San Joaquin Valley was found to meet all the necessary criteria. In the winter months there is a high probability of fog and low ceilings; also within a 60-mile radius of a suitable support base there are three airfields with the lighting systems to be evaluated.

It was discovered after several pre-validation flights that the airfield approach lighting systems that were flown against in California were better maintained than those in other parts of the United States. It was generally felt that the reason for this was because of the high incidence of fog and low ceilings in the winter months which necessitates the systems be kept in top-notch condition. In other parts of the United States, approach lighting systems were found to have poorly aimed sequenced flashers, inoperative

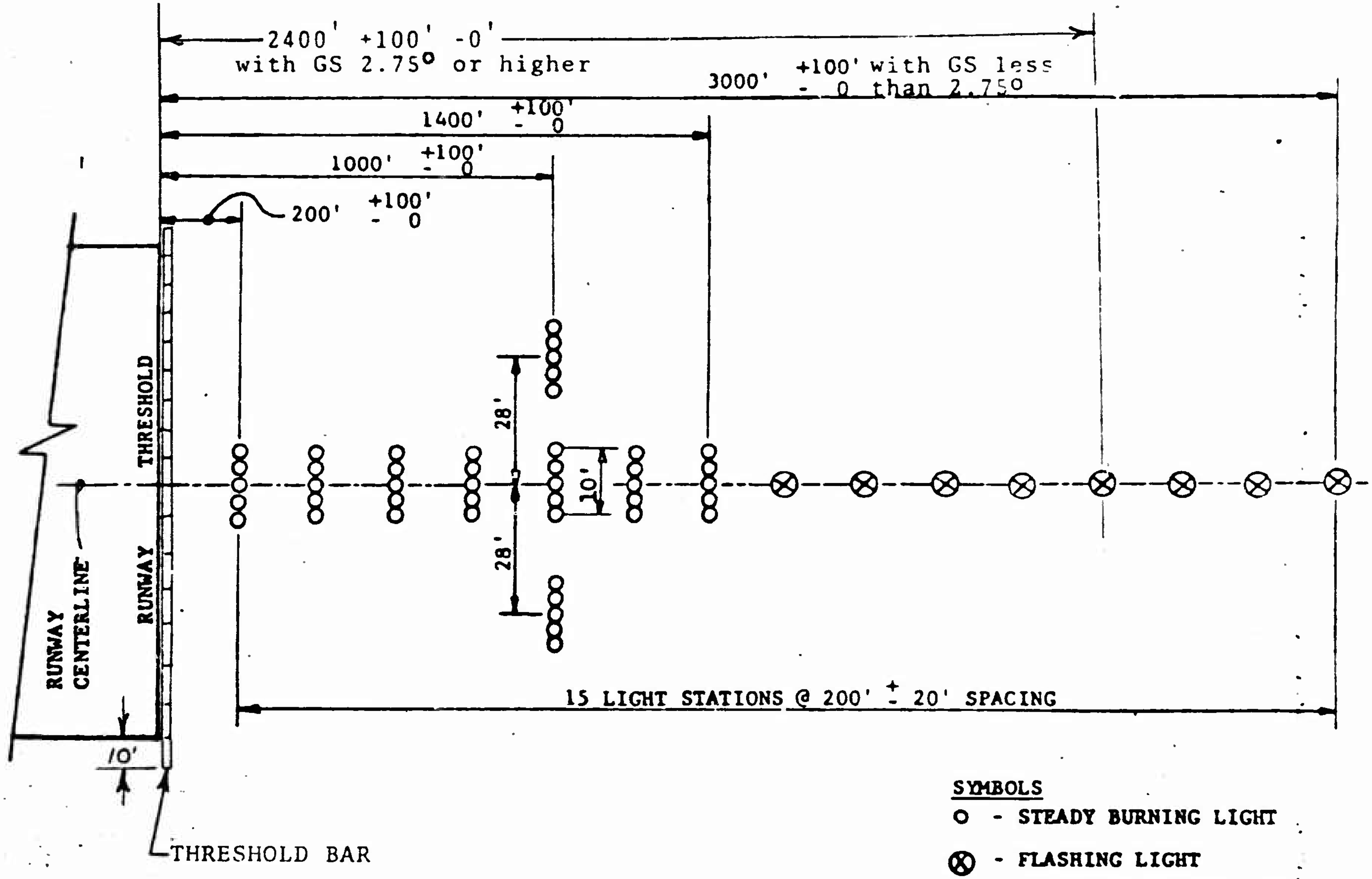

FIGURE 3. MALSR CONFIGURATION
2400 and 3000 FOOT SYSTEMS

SYMBOLS

o - **STEADY BURNING LIGHT**

⊗ - **FLASHING LIGHT**

- CONTINUOUS ROW OF GREEN LIGHTS WITH 10' spacing

sequenced flashers, and approach lights burned out or improperly aimed. When the sequenced flashers and approach lights were properly maintained and aimed to coincide with the instrument approach path, they could be acquired at a much greater distance from the runway.

Most airfields have gone to the MALSR system. Some of the older airfields located in areas where poor weather conditions are frequent, maintain ALSF-1 systems. Only three fields could be found with operable SSALR systems.

After some investigation it was found there is a vast difference in the intensity levels of the various approach lighting systems. When comparing the three approach lighting systems; the intensity level for ALSF-1 and modified SSALR are the same. The ALSF-1 and modified SSALR systems have a five-step intensity level. The sequenced flasher intensity level for these two systems is not varied.

The MALSR and SSALR systems have three brightness controls for the steady burning lights; high, medium, or low. Both systems take power from the runway edge lights to control the flasher intensity, therefore, the flasher intensity depends on the edge light step setting. When the runway edge lights are on steps five or four, the MALSR and SSALR systems are HIGH and the flasher intensity is 100%.

When the edge lights are step three, the MALSR and SSALR systems are MED, and the flasher intensity is 8% brightness (8% of what you normally see on an ALSF-1 or 2).

When runway edge lights are on steps two or one, the MALSR and SSALR systems are LOW, and the flashers are only 1%.

Table 1.

Runway Edge Light Step	SSALR MALSR Step	SSALR MALSR Steady Burning %	SSALR MALSR Flasher %
4 or 5	HIGH	100%	100%
3	MED	8%	8%
1	LOW	4%	1%

Approaches were flown with the lighing systems set at various intensity levels. Comments from the project pilot as to the distance sequenced flashers and approach lights were first seen as well as when they were lost from view on missed approach were recorded. Recording of the subject pilot's comments was accomplished by use of a small cassette tape recorder and wiring jack that plugged into the aircraft's interphone system. Notes were also taken

by the project pilot. During the initial flights against these approach lighting systems, it was felt some type of video recording device would be of value to review and analyze the approaches after the mission was completed. A Sony Video Rover #2 television camera with video tape recorder was tried. It was found after several flights, this camera would be difficult to mount and also present some difficulty for the subject pilots to operate without extensive training. The camera worked well for the daylight approaches, but proved totally unacceptable for recording approach lighting at night. A KB 26A gunsight camera was obtained. This will be mounted on the glare shield of the test aircraft when the Class II modification package is approved. It should prove to be invaluable for recording the approaches both during day and night conditions. In the interim, some film has been taken using a conventional super 8 movie camera.

When suitable weather conditions occur, i.e., low ceilings and visibility in the fall and winter months, the evaluation of the approach lighting systems will continue.